Quantifying Forest Vertical Structure Using Spaceborne Lidar: A GEO BON Essential Biodiversity Variable Application in Colombia

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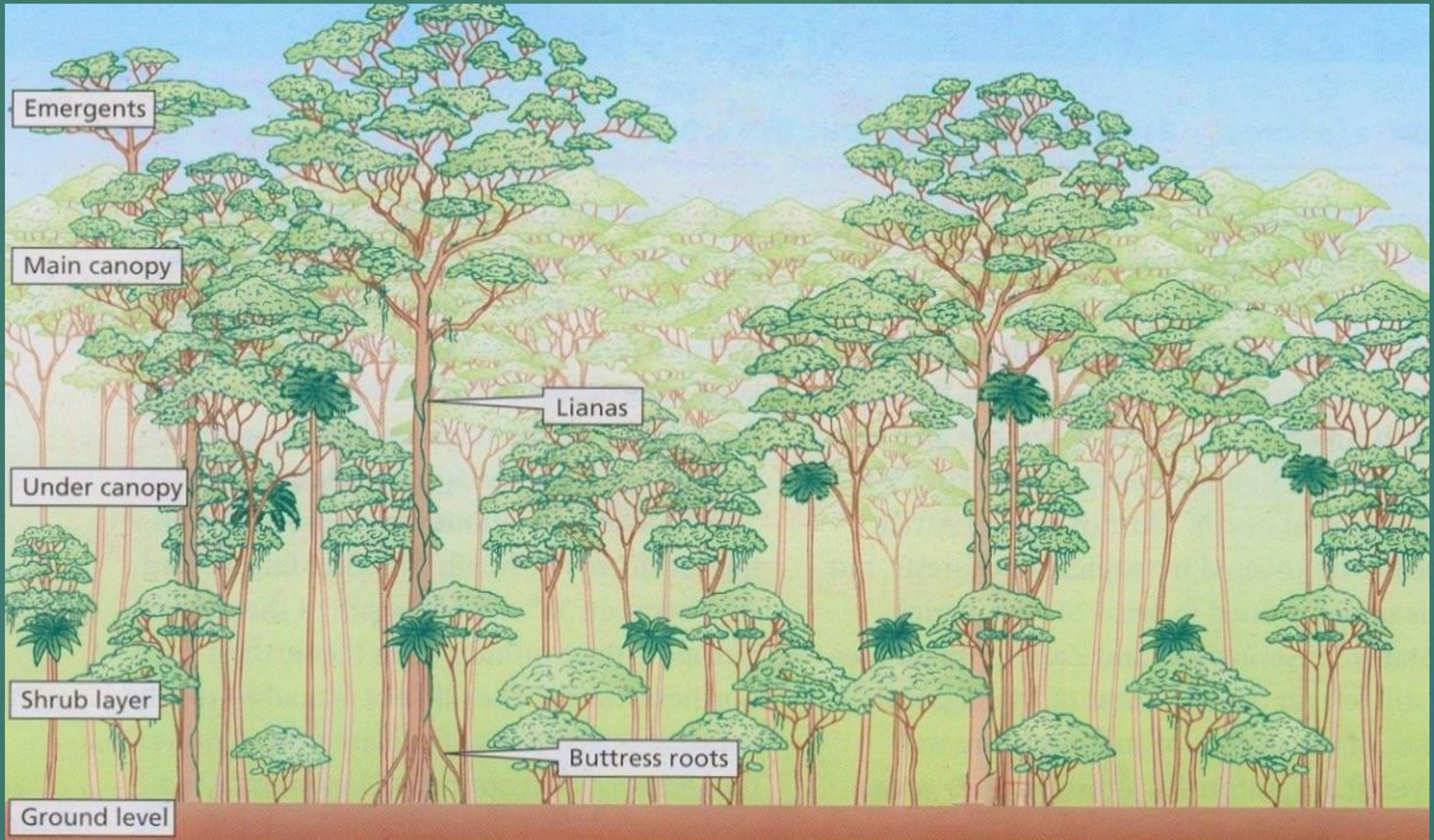
Ecosystem Structure

"Remote sensing measurements of cover (or biomass) by height (or depth) classes globally or regionally, to provide a 3-dimensional description of habitats." – GEO BON



Project Objectives

- Develop a consistent and scalable workflow that uses spaceborne lidar measurements to provide reliable estimates of the extent and distribution of forest structure types

- Work with the Humboldt Institute and other partners to incorporate forest structure data and workflows into Colombia’s biodiversity observation system


GEDI lidar
https://gedi.umd.edu

Vertical structure metrics from lidar footprints (canopy cover, height, and complexity

Footprints classified by forest structure type and stratified by region, protection status, and ecosystem type using Landsat derived forest maps and ancillary data

Forest structure type area and uncertainty estimates

<u>Pre-launch</u>
Prototype using GLAS footprints and simulated GEDI footprints derived from LVIS, G-LiHT, and other airborne lidar systems

<u>Post-launch</u>
Verify forest structure definitions using IAvH field plot data

Outputs

- Scripts and algorithms to access and process GEDI footprint data
- Forest structure definitions
- Documented workflow for deriving area of forest structure types and associated uncertainty
- Integrate classified footprint data and estimates with IAvH and BON in a Box spatial data portals and tools

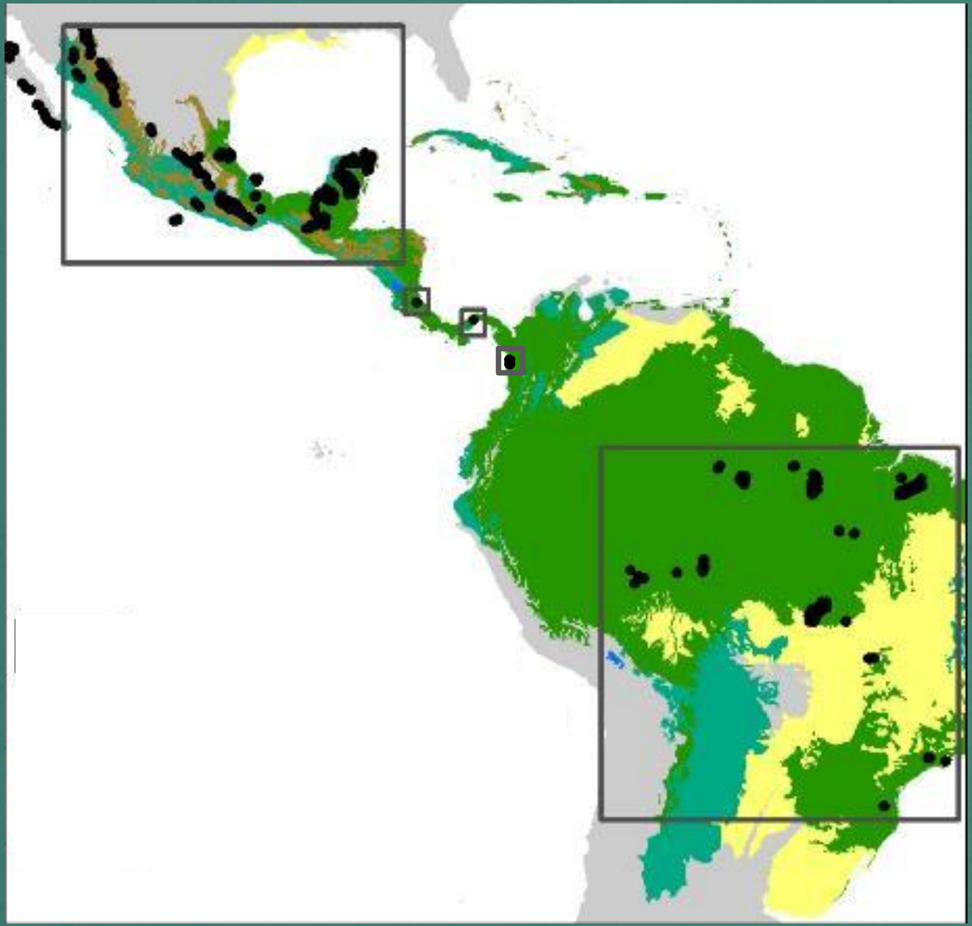
Communicate and transfer outputs to partners at IAvH and other stakeholders via webinars and annual technical workshops

Structure Type Mapping

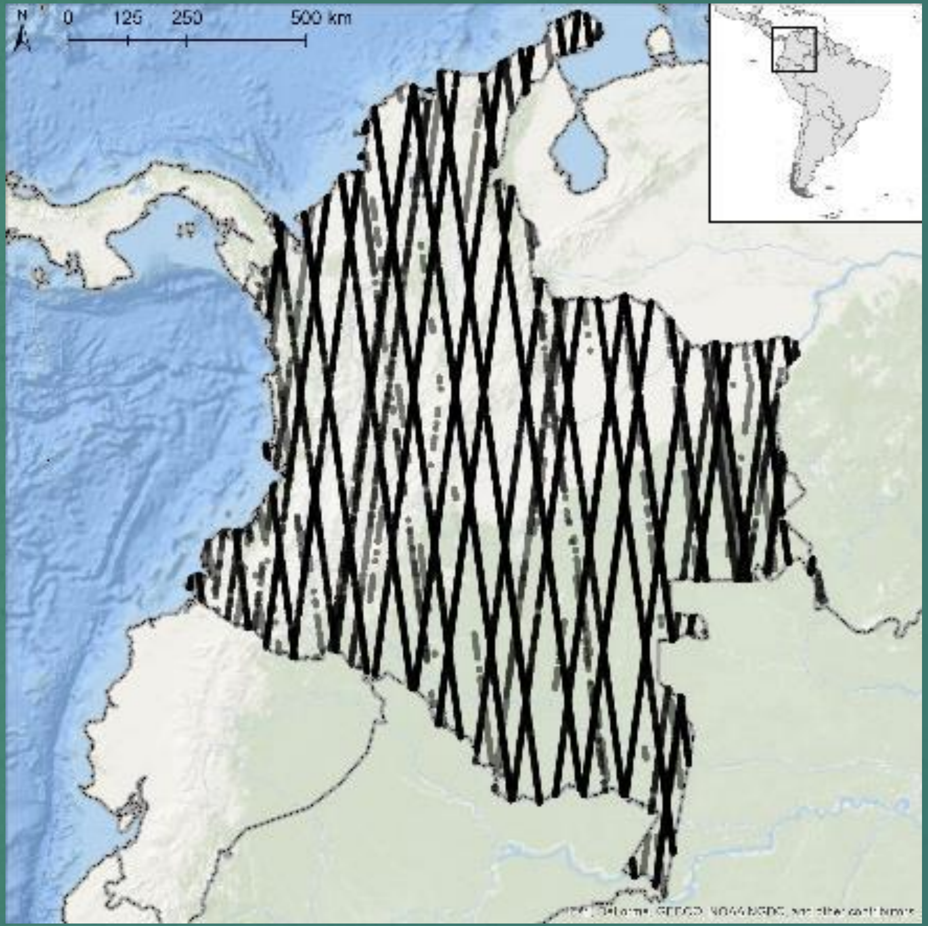
- Guo et al. 2017 - Regional mapping of vegetation structure for biodiversity monitoring using airborne lidar data

- Moran et al. 2018 - A data-driven framework to identify and compare forest structure classes using LiDAR.

Currently Available Data



Aircraft lidar acquisitions



GLAS acquisitions over Colombia

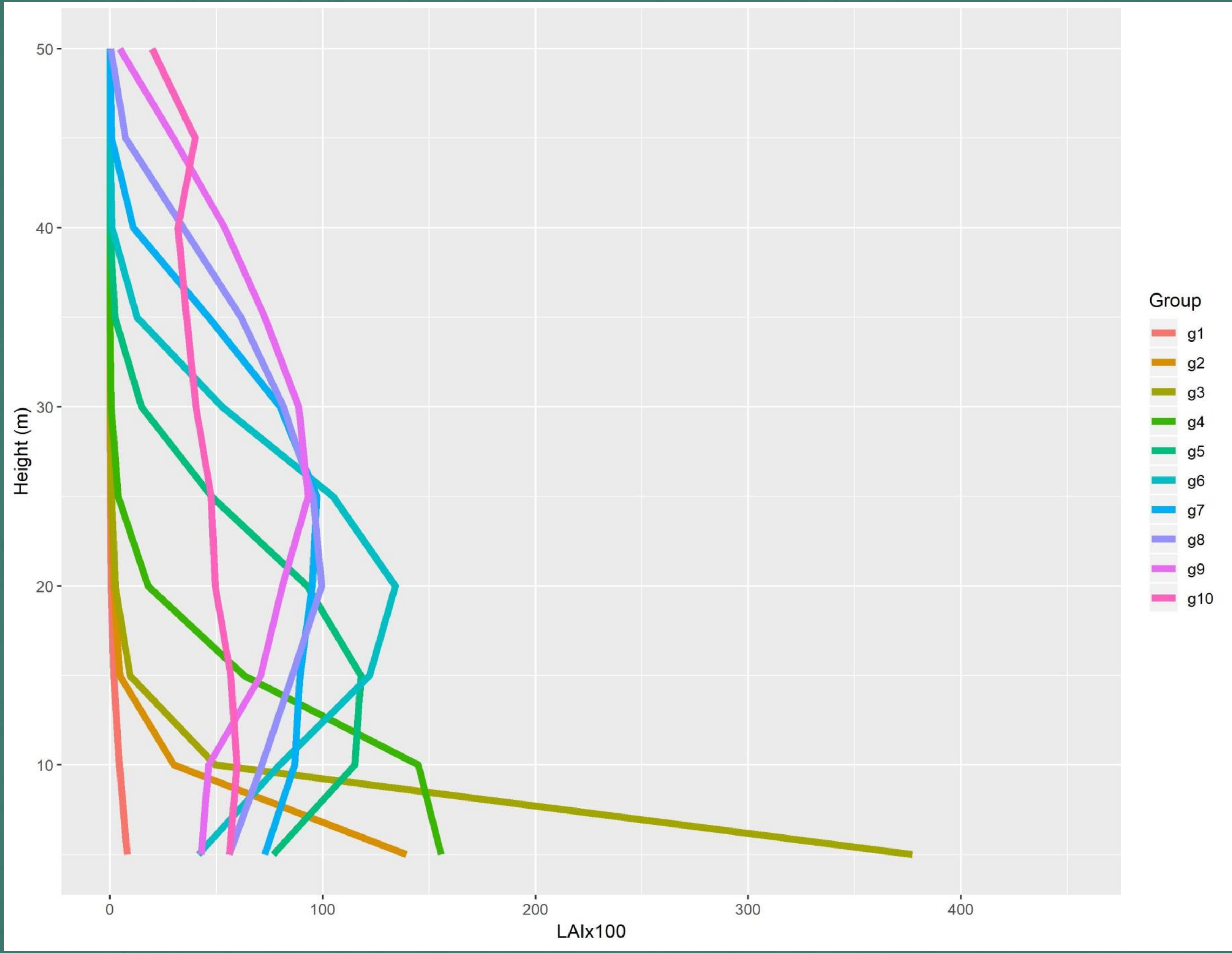
Strategy

- Area estimates of forest structure types
  - Data driven
  - Provides high level summary of forest structure in a given region
  - Prototype with GLAS

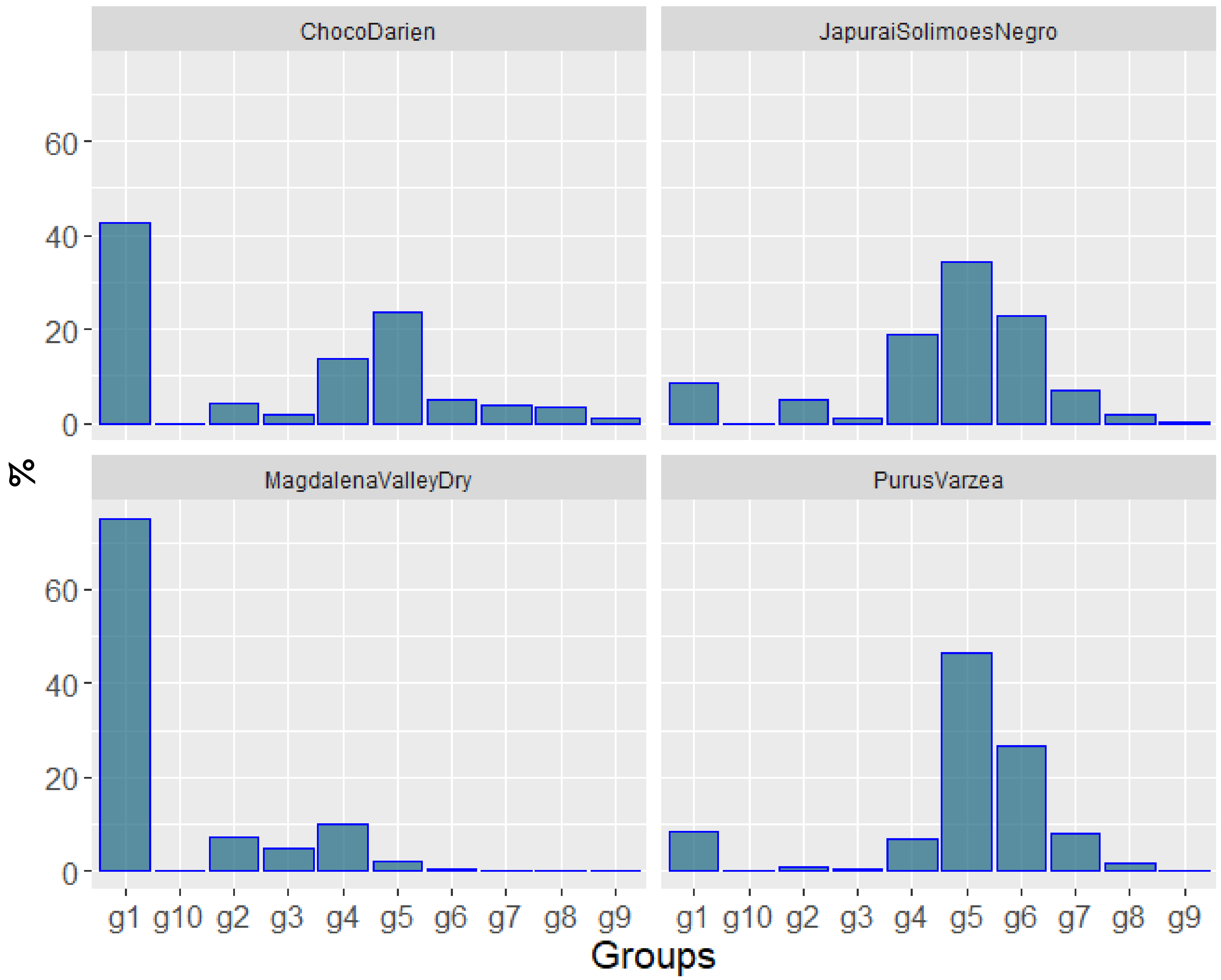
- Wall-to-wall predictions of canopy height
  - No gaps
  - Assess potential for using data from upcoming missions
  - Unclear what level of accuracy is needed for policy
  - Prototype with aircraft lidar + GEDI lidar simulations

Preliminary GLAS Analysis

- Tang et al. 2014 - Deriving and validating Leaf Area Index (LAI) at multiple spatial scales through lidar remote sensing: A case study in Sierra National Forest, CA.
- GLAS LAI – GORT - geometric optical and radiative transfer model
- Quality screened (slope <= 15deg, ground amplitude, < 150m diff between SRTM and GLAS elevation for clouds, signal to noise, overall energy)



Height (m)
50
40
30
20
10
0
100
200
300
400
LAIx100
Group
g1
g2
g3
g4
g5
g6
g7
g8
g9
g10


ChocoDarien
JapuraiSolimoesNegro
MagdalenaValleyDry
PurusVarzea
%
0
20
40
60
g1 g10 g2 g3 g4 g5 g6 g7 g8 g9
Groups

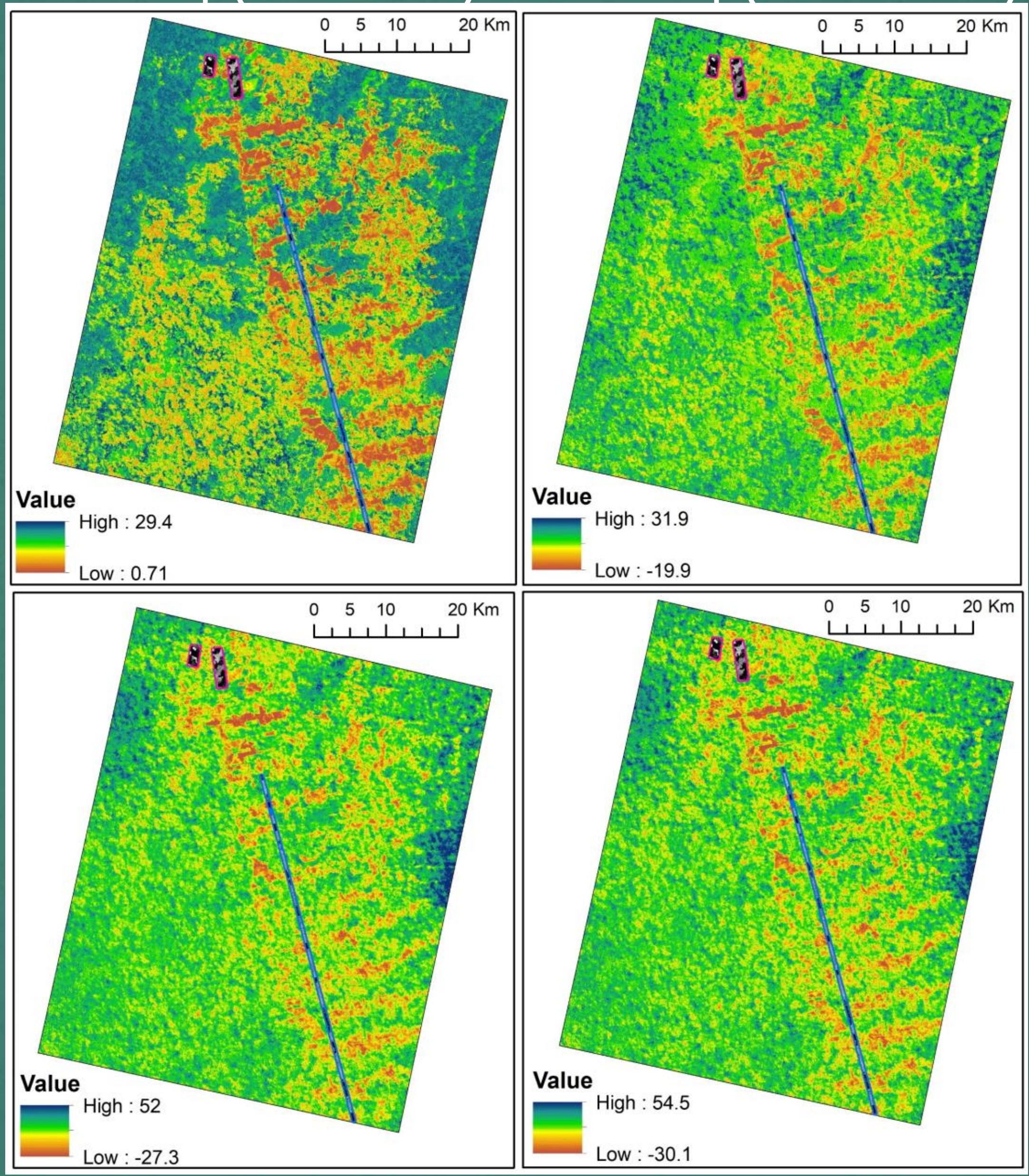
Next Steps

- Explore non-Euclidean distance/dissimilarity approaches for clustering (e.g. Random Forest dissimilarity)
- Improve representation of locally important but nationally rare classes
- Develop workflow and scripts for estimating forest structure type extents using multinomial proportions and land cover maps

Canopy Height Modeling

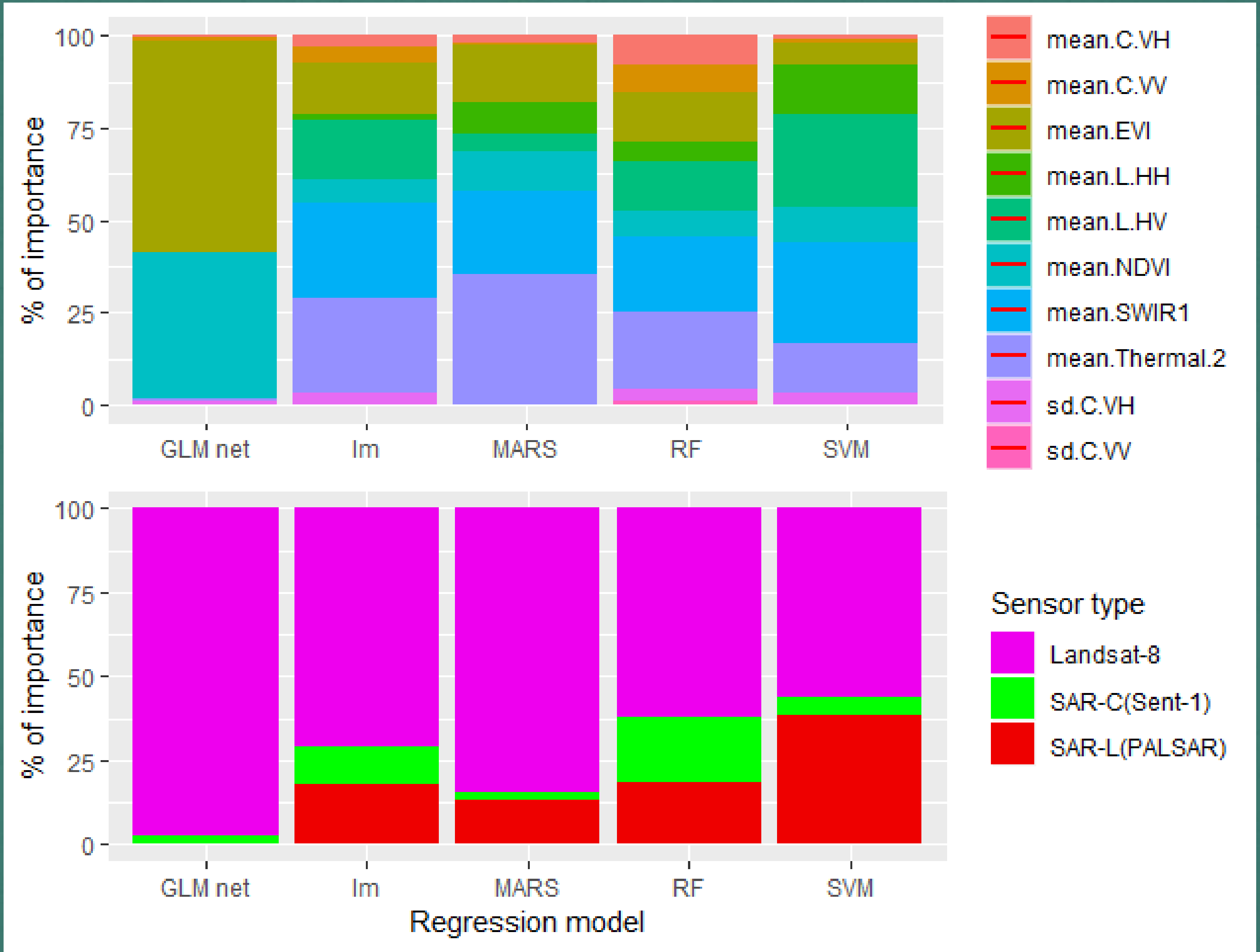
Tapajós-Xingu moist forest

RF map (RMSE = 7.4m) MARS map (RMSE = 7.58m)



lm map (RMSE = 7.92m) VSM map (RMSE = 7.97m)

Tapajós-Xingu moist forest



Application Readiness

- Held a workshop at Humboldt Institute in 2018 to introduce collaborators and other potential users to GEDI data
- Working with Humboldt Institute and other A.50 projects to ensure products are consistent with user needs and compatible with DSSs like BioTablero and BioModelos
- Developing a MOU with IDEAM to develop validation data and co-develop forest structure products

Questions

- Get footprints with height >= 5m
- Intersect footprints with IGBP forest class
- Calculate area of Colombia’s ecoregions in IGBP forest class
- Use the area times the proportion of footprints in each category as an estimate of the amount of forest structure type in each ecoregion